On Matching and Thickness in Heterogeneous Dynamic Markets

ITAI ASHLAGI, Stanford University.
MAXIMILIEN BURQ, MIT.
PATRICK JAILLET, MIT.
VAHIDEH MANSHADI, Yale University.

Additional Key Words and Phrases: Dynamic Matching, Heterogeneity, Market Design, Barter Exchange

Extended Abstract

Many matching markets are naturally dynamic. Every year thousands of incompatible patient-donor pairs register to kidney exchange clearinghouses that search periodically to match these pairs. Online platforms (dating, online workplace, etc.), labor markets, and even housing markets can be viewed as dynamic matching markets.

The matching policy, which determines when and who to match, plays an important role in the efficiency of the marketplace. A myopic policy, which attempts to match agents upon arrival, may have short run benefits but could harm future arriving agents. So a centralized clearinghouse may wait to thicken the market before identifying matches. In various marketplaces, the matching technology is also instrumental for efficiency. While kidney exchanges were first conducted in 2-way cycles (bilateral matches), most transplants are now conducted through chains initiated by an altruistic donor. This paper is concerned with the effects matching technologies and matching policies have on the efficiency of markets with different thickness levels.

We study a stylized infinite horizon model with two types of agents distinguished by their difficulty to match. Every period a single agent arrives to the market whose type is either *hard-to-match* (H), or *easy-to-match* (E). So the fraction of H agents joining the market, can be viewed as a measure for the market thickness, with a higher fraction interpreted as a thinner market. Agents in our model prefer to match as early as possible and are indifferent between acceptable matches. We focus on two types of matchings; bilateral and chains, and we assume that only one of these take place. We are interested in the behavior of the average waiting time for small values of p_H .

Our main contribution is identifying a tight connection between the fraction of H agents joining the market and the effect the matching technology has on efficiency. In particular, we find that when E agents join the market more frequently than H ones, myopic matching policies that use a chain, or just bilateral matches, are both approximately optimal. Otherwise, any bilateral matching policy is highly sub-optimal. Further, we show that no matching policy can reduce the average waiting time of H agents without significantly harming E agents, and thus any attempt to thicken the pool is artificial.

Finally, we discuss extensions of our model to include departures, independent arrival rates, two-sided markets, and decentralized markets.

First Draft: Feb 2014.

Full version at <http://arxiv.org/pdf/1606.03626v1.pdf>

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage, and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s). Copyright is held by the author/owner(s).

EC'16, July 24–28, 2016, Maastricht, The Netherlands.

ACM 978-1-4503-3936-0/16/07.

<http://dx.doi.org/10.1145/2940716.2940758>